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A STUDY OF THE FAUNAS OF THE RESIDUAL MISSISSIPPIAN OF PHELPS COUNTY (CENTRAL OZARK REGION), MISSOURI

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In the reports of the early writers on the geology of the Ozark region in Missouri mention is made of scattered patches of boulders containing fossils of "Chemung age" occurring in counties where no rocks of this age are in place or where they are but sparingly represented.

The investigations of Shumard, Meek, and Broadhead for the Missouri Bureau of Geology and Mines, between 1855 and 1871, published in 1873, mention such boulders from Maries, Miller, Morgan, Phelps, Wright, and Ozark counties.¹ This list of localities is doubtless incomplete, since much of the region was not examined by these workers. Meek assigned these boulders to the Lower Carboniferous, but Shumard and Broadhead employ the older term Chemung. Shortly before the publication of the report, the so-called "Chemung Group" of the older Missouri geologists was shown to be Lower Carboniferous, and in a footnote in Shumard's report on Ozark County,² he states that the term Chemung as employed in these reports is to be understood to mean Lower Carboniferous.

Broadhead again mentions these deposits in his report for 1873-74, as follows: "Fragmentary outliers of this group [Chouteau] are occasionally found capping the ridges near the Arkansas line."³

¹ Missouri Bur. of Geol. and Mines, *Reports of the Geological Survey of the State of Missouri*, 1855-71 (1873). See reports of the various counties named above.

² *Ibid.*, p. 190.

³ G. C. Broadhead in Missouri Bur. of Geol. and Mines, *Reports of the Geological Survey of the State of Missouri*, 1873-74 (1874), p. 27.

In 1898 Broadhead, writing on the Ozark uplift and the growth of the Missouri Paleozoic,¹ states that "beds of Chouteau limestone" have been found in Wright and Maries counties, and that the Burlington limestone has been recognized in Morgan, Benton, and Hickory counties, from which he concludes that at least the western half of the Ozark uplift was submerged during the Lower Carboniferous period.

The work of the present Missouri Bureau of Geology and Mines has given some additional information concerning the distribution of these deposits. Marbut,² Ball and Smith,³ Van Horn and Buckley,⁴ and Lee,⁵ working in different areas in the northwestern part of the Ozark region, have mentioned these deposits, but up to the present time no careful study has been made either of the distribution of this residual material or of its faunal content. In the literature it is commonly referred to as Chouteau or Burlington. In some localities these deposits are termed "residual Boone Cherts."

The purpose of the present paper is to present the results of a careful study of the faunas contained in a number of these boulders. The boulders which have furnished the material for this investigation were all collected within an area of about forty square miles situated in the extreme northeastern part of the Rolla quadrangle and the adjacent portion of Phelps County.

This area is a small plateau the summit of which is capped by resistant formations. The physiography and general geology of the region have been well described by Lee⁶ and need not be rediscussed here. The entire plateau is underlain by the Jefferson City dolomite of Canadian age, and lying unconformably upon

¹ G. C. Broadhead, "The Ozark Uplift and the Growth of the Missouri Paleozoic," Missouri Bur. of Geol. and Mines, Vol. XII (1898), *Areal Geology*, p. 398.

² C. F. Marbut, "Geology of Morgan County," Missouri Bur. of Geol. and Mines, Vol. VII (1907), 2d ser., pp. 49-51.

³ S. H. Ball and A. F. Smith, "Geology of Miller County," Missouri Bur. Geol. and Mines, Vol. I (1903), 2d ser., pp. 82-89.

⁴ F. H. Van Horn and E. R. Buckley, "Geology of Moniteau County," Missouri Bur. of Geol. and Mines, Vol. III (1905), 2d ser., pp. 44-58.

⁵ Wallace Lee, "Geology of the Rolla Quadrangle," Missouri Bur. of Geol. and Mines, Vol. XII (1913), 2d ser., pp. 41-43.

⁶ *Ibid.*, pp. 52-58, 13-40.

this are patches of non-fossiliferous sandstone and fire clays, which on lithologic grounds are classed as basal Pennsylvanian. The area covered by these Pennsylvanian deposits is not definitely known, but recent work has shown that its extent is much greater than has heretofore been supposed. It probably caps the divide almost continuously from Rolla to Cuba and for a considerable distance northeast of Cuba. Around the edges of this plateau where the Pennsylvanian is wanting, but where the Jefferson City formation is still in place, there are found small areas which are covered with Mississippian boulders. They rarely cover more than a few acres and may or may not be associated with similar deposits of Pennsylvanian age. They have an average vertical distribution of about thirty-five feet and a maximum of eighty feet. The total relief of the Rolla area is about five hundred feet, but the boulder patches are confined to the upper two hundred feet. They occur at lower levels in the northern part of the area, owing to the slight dip of the underlying formations.

The boulders almost invariably occur on the hillsides or in the heads of small ravines. A few patches have been found upon the hilltops, but in every case the crest of that particular hill was below the general summit-level. In the places where one of the boulder areas is associated with a small outlier of Pennsylvanian it may completely encircle it, but in most cases forms a fringe on one side only, which would seem to indicate that these boulder areas were localized in some manner before the deposition of the Pennsylvanian.

The exact nature of the Mississippian-Pennsylvanian unconformity is still doubtful. Outliers of Mississippian rocks occur in some parts of the Ozark region, but up to the present none have been found in this area. Small isolated patches of stratified Mississippian may be buried beneath the Pennsylvanian, but at the present time no such occurrences have been reported. At one locality fragments of the Mississippian have been found in the basal conglomerate of the Pennsylvanian,¹ but such association is not common. It may be that these patches of boulders are the remnants of small outliers which have been reduced to this stage since the

¹ Wallace Lee, *op. cit.*, p. 44.

erosion of the Pennsylvanian, but there is also the possibility that these deposits were in the boulder form before the invasion of the Pennsylvanian seas. In either case the character of the boulders seems to indicate that they have not been moved far from their place of origin, if they have been moved at all.

Lithologically the boulders fall into a number of well-marked groups. The more abundant ones are of course, dense, quartzitic sandstone, which in its original state was probably a calcareous sandstone. In their present condition the calcium carbonate content has been completely removed by leaching, and thin sections show them to be made up entirely of clear quartz grains exhibiting little evidence of secondary growth. The interior of these boulders is semi-translucent, bluish white in color, and the rock is quite hard and dense, but the more weathered, external portions are extremely porous and deeply stained with iron oxide. They are abundantly fossiliferous, but the fossils are scattered irregularly through the rock with no arrangement that would suggest bedding. Associated with the quartzitic boulders are masses of soft, friable, fine-grained white sandstone, which are somewhat leached and in which the more weathered phases are deeply stained with iron oxide. Otherwise the rock is but little altered. The fossils of these sandstone masses are arranged in parallel bands, which probably correspond to the bedding planes of the formation.

Boulders of chert are also abundant. Some are practically unweathered, others are so completely leached that they powder under the hammer. For the most part they are white or pale bluish white in color, and, like the sandstone boulders, they are stained with iron oxide in proportion to the amount of weathering which they have undergone. At one locality a single chert boulder has been found which is of a pale pink color, the color appearing to be original.

Lee¹ has mentioned that boulders of siliceous oölite of Mississippian age occur at one locality associated with boulders of the quartzitic type. A careful examination of such oölite boulders from this and other localities where they are associated with residual

¹ *Ibid.*, p. 42.

Mississippian deposits has failed to disclose any determinable Mississippian fossils. Some of the oölite is conglomeratic, containing small angular chert pebbles, and much of it contains small cavities, some rounded, others angular, which simulate the impression of poorly preserved fossils. Lee has suggested that this oölite is the possible equivalent of the Short Creek oölite of southwestern Missouri. The writer has not seen Lee's collections from the fossiliferous oölite, and his own observations have not confirmed Lee's. Bowlders of siliceous oölite are abundant in the residual material over a large part of this area. There are beds of it in the Jefferson City formation, and some oölite bowlders have been found which contain Canadian fossils. On the other hand, many of the oölite bowlders are weathered and stained with iron oxide in much the same manner as are the Mississippian bowlders, while others do not seem to have been weathered in this manner.

The association of the different types of bowlders seems to follow no general rule. In some localities they consist exclusively of sandstones, while in others chert predominates, but in nearly every case examples of all the easily recognized lithologic types are to be found together.

The fossils are in most cases preserved as molds of the exterior and as casts of the interior. In rare instances the shell itself, together with the internal structures, has been completely silicified. In many examples the molds and internal casts preserve the markings of the original with great fidelity, and excellent squeezes may be obtained from them. Some difficulty has been experienced in correlating the mold with the internal cast, for, strangely enough, when one surface is well preserved, the other often is not.

The material used in the preparation of this paper has come from three sources: (1) a collection belonging to the Department of Geology of the Missouri School of Mines and Metallurgy, lent by Professor Cox and Professor Dake; (2) some collections belonging to the Missouri Bureau of Geology and Mines, lent by Mr. Buehler; and (3) a number of collections made by the writer and his friends. These were made while the writer was connected with the Missouri School of Mines and are the property of that institution.

At the outset it was realized that in order to get decisive results the faunas of each individual boulder must be kept together so that the natural association of species might be determined. This has been done, and a record of the localities from which the individual boulders have come has also been kept. The original collection of the School of Mines was made without regard to the first factor and with but slight regard to the second, so that, while it contains many fine specimens which have been of great value in making comparisons, it has been useless for exact stratigraphic purposes. The collections of the Missouri Survey and those made by the writer were made with both of the above-mentioned points in view, and all of the conclusions drawn from this study are based upon the faunas which they have yielded. Numbers have been assigned to the several localities from which collections have been made, and these, together with the location, are given in the accompanying list.

REGISTER OF LOCALITIES, PHELPS COUNTY, MISSOURI

1. T. 38 N., R. 8 W., N.E. $\frac{1}{4}$, S.E. $\frac{1}{4}$, Sec. 36.
2. T. 38 N., R. 8 W., N.E. $\frac{1}{4}$, N.E. $\frac{1}{4}$, Sec. 36.
3. T. 38 N., R. 8 W., S.W. $\frac{1}{4}$, S.E. $\frac{1}{4}$, Sec. 25.
4. T. 37 N., R. 8 W., N.W. $\frac{1}{4}$, S.W. $\frac{1}{4}$, Sec. 26.
5. T. 37 N., R. 8 W., Center line S. $\frac{1}{2}$, Sec. 25.
6. T. 38 N., R. 8 W., S.E. $\frac{1}{4}$, S.W. $\frac{1}{4}$, Sec. 27.
7. T. 38 N., R. 8 W., W. $\frac{1}{2}$, S.W. $\frac{1}{4}$, Sec. 27.
8. T. 37 N., R. 8 W., S.W. $\frac{1}{4}$, S.W. $\frac{1}{4}$, Sec. 24 and adjoining corners in Secs. 24 and 25.
9. T. 38 N., R. 8 W., S.W. $\frac{1}{4}$, S.E. $\frac{1}{4}$, Sec. 35.
10. T. 38 N., R. 8 W., N.W. corner N.W. $\frac{1}{4}$, N.E. $\frac{1}{4}$, Sec. 35.
11. T. 38 N., R. 8 W., N.W. $\frac{1}{4}$, N.W. $\frac{1}{4}$, Sec. 36.
12. T. 38 N., R. 8 W., Center S.E. $\frac{1}{4}$, Sec. 26.

MARIES COUNTY, MISSOURI

1. T. 40 N., R. 8 W., Sec. 7.

Lee's map shows the location of most of the localities listed above.

The oldest Mississippian fauna which this area has yielded is contained in the boulder of pink chert, mentioned on page 561. The boulder is case-hardened and stained with iron oxide to the

depth of about one-eighth of an inch. It is somewhat leached, but otherwise is scarcely weathered. The following fauna was obtained:

FAUNA OF BOWLDER 28, LOCALITY 7

Coelenterata

Zaphrentidae

Gen. ? sp. ?

Cyathaxonidae

Cyathaxonia sp.

Echinodermata

Platycrinus sp. (stem fragments)

Unidentified stem and other fragments

Molluscoidea

Fenestella burlingtonensis Ulr. ?

Rhombopora sp.

**Productus sampsoni* Weller ?

Rhipidomella diminutiva Rowley

Camarotoecchia tula (Miller)

**Dielasma fernglenensis* Weller

Terebratuloid shell gen. ? sp. ? (3 forms)

**Cyrtina burlingtonensis* Rowley

Spirifer sp. (small form, probably young shell)

**Spiriferina subtexta* White

**Brachythyris fernglenensis* Weller ?

Ambocoelia levicula Rowley

Ambocoelia sp.

Reticularia cooperensis (Swallow)

**Ptychospira sexplicata* (W. & W.)

**Athyris lamellosa* (Leveille)

**Cliothyridina glenparkensis* Weller ?

A comparison of this fauna with the Fern Glen fauna described by Weller¹ shows that the two have very close relationships. While the fauna of this boulder is not as large as that of the Fern Glen, the majority of its determined forms are identical with, or closely related to, Fern Glen species. In the faunal list given above the species occurring in the Fern Glen fauna have been designated by an asterisk. Of the ten certainly identified brachiopods, six are recorded in the Fern Glen fauna, and three others, doubtfully identified, are also represented in the Fern Glen. The

¹ Stuart Weller, "Kinderhook Faunal Studies, V, The Fauna of the Fern Glen Formation," *Bul. Geol. Soc. Amer.*, XX (1909), 265-332.

genus *Cyathaxonia* is abundantly represented in the Fern Glen fauna, and *Platycrinus* and *Rhipidomella* also occur. *Camaro-toechia tuta* and *Ambocoelia levicula* are both found in the Lower Burlington limestone, while *Reticularia cooperensis* appears to be a survival from the late Kinderhook. The relationships of this fauna are so definite that there is no hesitation in calling it the equivalent of the Fern Glen fauna.

A somewhat younger fauna has been obtained from a number of quartzitic boulders, and the faunas of the four best boulders containing this fauna have been combined to form the list given in Table I.

A comparison of the four faunas listed (p. 566) shows that they are closely related. Only one species is common to all four faunas, but three species are common to faunas Nos. 3 and 5, seven to faunas Nos. 31 and 5, five to faunas Nos. 17 and 5, etc. The boulders in which these faunas were contained were all small, and this would partially account for some of the diversity.

The affinities of these faunas are with the Burlington rather than with the Kinderhook. Many of the species are common to the Upper Kinderhook and the Lower Burlington, and recent work has suggested that some beds which have commonly been referred to the upper part of the Kinderhook are more nearly related to the base of the Burlington. This fauna is not the equivalent of the Fern Glen fauna just described; neither is it the exact equivalent of the fauna of the Burlington White Chert from Louisiana, Missouri, but appears to be intermediate between the two. Very few faunas have been described from this horizon, and, until more definite work is done on this portion of the Mississippian, a more exact correlation cannot be made.

The faunas of the eight boulders listed in Table II have much in common, and undoubtedly are from a common horizon.

Of the 72 forms listed in Table II, 50 are found in the Burlington of various localities, and at least 11 more occur in the Fern Glen and in beds of equivalent age. A few forms hitherto reported only from the Upper Kinderhook and Chouteau—*Chonophyllum sedaliense*, *Reticularia cooperensis*, *Productus blairi*, and *Hustedia circularis*—are also recorded. Some of these are definitely identified;

the presence of others is doubtful, but their presence does not affect the correlation of the faunas. Some of the bryozoans listed

TABLE I

Locality No..... Boulder No.....	7 31	10 3	10 5	10 17
Coelenterata				
<i>Zaphrentis calceola</i> W. & W.	x	x	x	x
Echinodermata				
<i>Cryptoblastus melo</i> O. & S.			x	
<i>Platycrinus</i> ? sp.				x
Undet. crinoid base.			x	
Molluscoidea				
<i>Fenestella</i> cf. <i>F. exigua</i> Ulr.				x
<i>Polypora</i> sp.			x	
<i>Schellwienella</i> sp.	x		x	
<i>Chonetes multicosta</i> Winchell.			x	x
<i>Chonetes</i> sp. undesc.		x		
<i>Productus sampsoni</i> Weller.			x	
<i>Productus fernglenensis</i> Weller.	x		?	
<i>Productus burlingtonensis</i> Hall.			?	
<i>Productus</i> sp.			x	
<i>Rhipidomella diminutiva</i> Rowley.	x	x		
<i>Schizophoria chouveauensis</i> Weller.	x			
<i>Schizophoria swallowi</i> (Hall).	x			
<i>Schizophoria subelliptica</i> (W. & W.).		x		
<i>Schizophoria</i> sp.			x	
<i>Camarotoechia</i> sp.			x	x
<i>Rhynchopora</i> sp.			x	
<i>Cranaena globosa</i> Weller.				x
<i>Dielasma osceolensis</i> Weller?				x
<i>Spiriferina</i> sp.		x		
<i>Spirifer osagensis</i> Swallow.	x	x	x	
<i>Spirifer vernonensis</i> Swallow.	x		x	
<i>Spirifer latior</i> Swallow.	x			
<i>Spirifer louisianensis</i> Rowley.	x		x	x
<i>Spirifer legrandensis</i> Weller.	cf.			
<i>Spirifer platynotus</i> Weller.	?	x		
<i>Spirifer biplicoides</i> Weller.			x	x
<i>Spirifer</i> sp. nov.			x	
<i>Spirifer</i> sp.			x	
<i>Spirifer</i> sp.			x	
<i>Brachythyris</i> ? sp.	x			
<i>Syringothyris</i> sp.	x			
<i>Ambocoelia levicula</i> Rowley.		x	x	
<i>Nucleospira obesa</i> Rowley.	x			
<i>Chiothyridina tenuilineata</i> (Rowley) ..				x
Mollusca				
<i>Conocardium</i> sp. nov.	x		x	
<i>Euomphalus latus</i> Hall.	x	x		
<i>Platyceras obliquus</i> (Keyes).				x
<i>Orthonychia</i> sp.	x			
<i>Igoceras</i> ? sp.			x	
Arthropoda				
<i>Phillipsia meramecensis</i> Shumard.				x

TABLE II

Locality No. Boulder No.	1 MGS 2	4 101	5 100	10 4	10 2	10 27	1 MGS 1	12 MGS 3
Coelenterata								
<i>Zaphrentis calceola</i> W. & W.	x	x		x			x	x
<i>Zaphrentis</i> sp. undet.								x
<i>Zaphrentis</i> sp. undet.								x
<i>Zaphrentis</i> sp. undet.							x	
<i>Triplophyllum centralis</i> (E. & H.)		x						
<i>Triplophyllum</i> sp.		x						
<i>Amplexus fragilis</i> White & St. John		x						
<i>Chonophyllum sedaliense</i> White		x						
Echinodermata								
<i>Cryptoblastus melo</i> O. & S.				x			x	x
<i>Balocrinus?</i> <i>tuberculatus?</i> W. & S.						x		
<i>Aorocrinus?</i> ? sp.							x	
<i>Actinocrinidae</i> gen. ? sp. ?							x	
<i>Platycrinus sculptus</i> Hall		cf.						
<i>Platycrinus</i> sp. (several)	3	x	x		x		x	2
Crinoid fragments, plates, stems	x	x	x	x	x	x	x	x
Molluscoidea								
<i>Fenestella filistriata</i> Ulr.	?					?		
<i>Fenestella multispinosa</i> Ulr.	?		?					
<i>Fenestella compressa</i> var. <i>elongata</i> Cumings	x	x						x
<i>Fenestella burlingtonensis</i> Ulr.						?		
<i>Fenestella?</i> sp.						x		
<i>Fenestella?</i> sp.								x
<i>Fenestella?</i> sp.	x							
<i>Hemitrypa?</i> sp.	x							
<i>Fenestelloid</i> gen., sp.	x							
<i>Rhombopora</i> sp.	x							
<i>Glyptopora</i> sp.								x
<i>Leptaena analoga</i> (Phillips)		x						
<i>Schellwienella alternata</i> Weller	x							
<i>Schellwienella inflata</i> W. & W.	cf.	x						
<i>Schellwienella burlingtonensis</i> Weller		x		x				x
<i>Schellwienella</i> or <i>Streptorhynchus</i> sp.		x		x				x
<i>Streptorhynchus</i> sp.		x						
<i>Chonetes glenparkensis</i> Weller	x							
<i>Chonetes multicosta</i> Winchell				x				x
<i>Chonetes illinoisensis</i> Worthen							x	x
<i>Chonetes logani</i> N. & P.								x
<i>Chonetes</i> sp. nov.		x						
<i>Chonetes</i> sp.	x							
<i>Chonetes</i> sp.						x		
<i>Productella concentrica</i> (Hall)		x					x	
<i>Productella millespinosa</i> Girty						x		
<i>Productus ovatus</i> Hall	x					?		x

TABLE II—*Concluded*

Locality No. Boulder No.	1 MGS 2	4 101	5 100	10 4	10 2	10 27	1 MGS 1	12 MGS 3
Mulloscoidea—Continued								
<i>Pseudosyrinx missouriensis</i> Weller						x		
<i>Ambocoelia levicula</i> Rowley ..	x		x		x	?		
<i>Reticularia cooperensis</i> (Swal- low)	x					x	x	x
<i>Ptychospira sexplicata</i> (W. & W.)	?							
<i>Eumetria?</i> sp.	x							
<i>Hustedia circularis</i> (Miller) ..						x		
<i>Nucleospira obesa</i> Rowley	x							
<i>Rowleyella fabulites</i> (Rowley) ..						x		
<i>Athyris lamellosa</i> (Leveille) ..						x		
<i>Cliothyridina tenuilineata</i> (Rowley)	x	x					x	x
<i>Composita</i> sp.		x						
Mollusca								
<i>Conocardium</i> sp. nov.		x	x					
<i>Cypricardina</i> sp.							x	x
<i>Laevidentalium</i> sp.	x							
<i>Lepelopsis</i> sp.	x							
<i>Pleurolomaria sedaliensis</i> Mil- ler			x					
<i>Platyschisma?</i> <i>depressa</i>		cf.						
<i>Euomphalus latus</i> Hall		x	x				x	x
<i>Strophostylus bivolve</i> W. & W. ..	x				x			x
<i>Orthonychia</i> sp.								x
<i>Orthonychia</i> sp.	x		x			x		x
<i>Platyceras nasutus</i> Miller		?						
<i>Platyceras paralius</i> W. & W.							x	
<i>Platyceras obliquus</i> Keyes								x
<i>Platyceras</i> sp.						x		
Arthropoda								
<i>Phillipsia tuberculata</i> M. & W. ..	x	x						
<i>Griffithides sedaliensis</i> Vogdes ..	x	x	x		x			

above have been described from higher formations only, but as yet the exact range of the Mississippian fenestelloid species is imperfectly known, and such species might well be represented in the earlier faunas. The presence of such fossils as *Centronelloidea rowleyi*, *Rowleyella fabulites*, *Nucleospira obesa*, and *Ambocoelia levicula*, which are characteristic of the white chert division of the Lower Burlington at Louisiana, Missouri, together with the great assemblage of Lower Burlington forms, would seem to indicate that this was the proper correlation for these faunas.

Boulder No. 16, Locality 10, has yielded but two forms—*Syringothyris platypleurus* Weller, and *Conocardium* sp. nov. The former is a typical Lower Burlington form, and the latter is identical with forms described from the boulders referred to the Burlington white chert. While it is not possible to place such a small fauna definitely, such evidence as there is seems to indicate that it should be correlated with the boulders which have just been described. These faunas, with the exception of the one from boulder No. 27, were obtained from boulders of sandstone or quartzite. Boulder No. 27 was composed of white chert. As a general rule, however, it may be stated that the Burlington faunas are to be looked for in the quartzite boulders, and the younger and older faunas in the cherts.

A number of other boulders have yielded faunas which are apparently Lower Burlington in age, but which do not contain a fauna which may be classed as being truly representative. These faunas are listed below:

LOCALITY 10—BOWLDER NO. 1

Platycrinus sp.

Cliothyridina tenuilineata (Rowley)

LOCALITY 10—BOWLDER NO. 6

Productus sp.

Rhipidomella diminutiva Rowley

Terebratuloid shell gen. ? sp. ?

Spirifer biplicoides Weller

Spirifer gregeri Weller?

Spirifer sp.

LOCALITY 12—BOWLDER NO. 19

Fenestella compressa var. *elongata* Cumings?

Brachythyris sp.

Phillipsia tuberculata M. & W.

LOCALITY 7—BOWLDER NO. 21

Spirifer platynotus Weller

Spirifer rowleyi Weller?

Spirifer sp. nov.

Unidentified crinoid

The largest fauna which has thus far been obtained has come from a large chert boulder which was found by Professor Dake.

This boulder is so completely weathered that the original texture is entirely gone, and in its place is a porous siliceous mass which powders and crumbles and breaks irregularly. The original bedding of the formation to which this boulder belonged is well preserved in the specimen and is indicated by a slight lithologic change and a more marked faunal change. Crinoid fragments and pieces of bryozoans are to be found in all parts of the mass, but the former are much more abundant on one side and the latter on the other, and the dividing line is plainly marked. At first an attempt was made to keep the faunas of the two sides separate, but it was soon found that specimens of practically all the species represented were found on both sides of the boulder. The two faunas are therefore treated as one.

FAUNA OF BOWLDER 102—LOCALITY 1

Coelenterata

Amplexus fragilis White & St. John

Monolispora beecheri Grabau

Gen. ? sp. ?

Echinodermata

Codaster sp. nov.

Platycrinus hemisphericus M. & W.

Platycrinus pratteni Worthen ?

Platycrinus sp., at least five species, probably more

Dichocrinus scitulus Hall ?

Dichocrinus sp.

Fragments

Molluscoidea

Fenestella cestriensis Ulr. ?

Fenestella cingulata Ulr.

Fenestella compressa Ulr.

Fenestella compressa var. *elongata* Cumings

Fenestella compressa var. *nododorsalis* Ulr.

Fenestella exigua Ulr. ?

**Fenestella filistriata* Ulr.

**Fenestella filistriata* Ulr. ?

Fenestella funicula Ulr.

Fenestella limitaris Ulr.

Fenestella multispinosa Ulr.

Fenestella multispinosa Ulr. ?

Fenestella regalis Ulr.

Fenestella rudis Ulr.

- Fenestella tenuissima* Cumings
Fenestella triserialis Ulr.
Fenestella triserialis Ulr. ?
Cystodictya lineata Ulr.
 **Polypora burlingtonensis* Ulr.
Polypora gracilis Prout
Polypora hallana Prout
Polypora maccoyana Ulr.
Polypora radialis Ulr.
Pinnatopora conferta Ulr.
Hemitrypa perstriata Ulr. ?
Rhombopora dichotoma Ulr. ?
Rhombopora incrassata Ulr. ?
 **Schellwienella burlingtonensis* Weller
 **Productus parvulus* Winchell
 †*Productus ovalis* Hall
Productus mesalis Hall ?
Pustula biseriatus (Hall)
 **Rhipidomella diminutiva* Rowley
 **Schizophoria subelliptica* (W. & W.)
Tetracamera missouriensis Weller
Rhynchopora beecheri Greger
 **Dielasma burlingtonensis* (White)
 **Cyrtina burlingtonensis* Rowley
Cyrtina neogenes Hall and Clarke
 **Spiriferina solidirostris* White
Spiriferina norwoodana (Hall)
Delthyris similis Weller
Spirifer rostellatus Hall
Spirifer logani Hall
Spirifer tenuimarginatus Hall ?
Spirifer tenuicostatus Hall
 †*Brachythyris suborbicularis* Hall
Pseudosyrinx keokuk Weller
Reticularia pseudolineata (Hall)
Eumetria verneuilliana Hall
 **Nucleospira obesa* Rowley
 **Cliothyridina incrassata* (Hall)
Cliothyridina parvirostris (M. & W.)

Mollusca

- Cypricardinia* sp.
Orthonychia pabulocrinus (Owen)
Platyceras obliquus (Keyes)
Platyceras equilateralis Hall
 Undetermined forms

Arthropoda

**Phillipsia tuberculata* M. & W.*Griffithides sedaliensis* Vogdes

A careful comparison of this fauna with the extensive collection in the Walker Museum, from the Keokuk and Warsaw formations from a number of localities in the Mississippi Valley, has indicated the approximate age of the fauna, but does not allow it to be placed exactly. Its affinities are with the Upper Keokuk and Lower Warsaw. What little evidence there is seems to favor the placing of this boulder in the Lower Warsaw.

Spiriferina norwoodana, *Pustula biseriatus*, *Delthyris similis*, *Fenestella exigua*, *F. funicula*, *F. compressa* var. *nododorsalis*, *Polypora gracilis*, and *Pinnatopora conferta* occur in the Lower Warsaw at a number of localities. *Eumetria verneuilliana*, *Pseudosyrinx keokuk*, and *Monolipora beecheri*, while found in both formations, appear to be more abundant in the Lower Warsaw. On the other hand, *Fenestella rudis*, *F. regalis*, *Polypora hallana*, and *P. maccoyana* have heretofore been identified from the Keokuk only. *Spirifer rostellatus* is well known in the Keokuk, but its presence in the Warsaw has been regarded as doubtful.

An interesting recurrent Burlington association appears in this boulder, the species of which are indicated in the faunal list by an asterisk. A few other species which are common to many Mississippian formations are indicated by the dagger. This recurrent element corresponds almost exactly to the faunas assigned to the Burlington white chert. It is known at the present time that such a recurrent group of species does occur either in the top of the Keokuk formation or in the base of the Warsaw, in southeastern Missouri, and this boulder was undoubtedly from this horizon originally.

Closely related to the fauna just described are the three faunas listed below:

BOWLDER 13—LOCALITY 10

Archimedes owenanus Hall

MISSOURI BUREAU OF GEOLOGY AND MINES, COLLECTION NO. 4, LOCALITY 12

Archimedes grandis Ulrich*Orthotetes keokuk* (Hall)*Productus ovatus* Hall

BOWLDER 34—LOCALITY 6

Fenestella rudis Ulrich?

Archimedes grandis Ulrich

Productus ovalus Hall

Productus setigerus Hall

Rhynchopora beecheri Greger

Pseudosyrinx keokuk Weller

Camarophoria? sp.

The exact correlation of these faunas is a difficult matter, since nearly all of the species represented are common to both the Keokuk and the Lower Warsaw. *Archimedes owenanus* is a common Keokuk form, but it also appears in the Lower Warsaw. *A. grandis* is less common, but its stratigraphic range is believed to be about the same as that of *A. owenanus*. *A. wortheni*, which is so characteristic of the Warsaw faunas, has not been found. These faunas are probably best classed as Keokuk. No trace of the recurrent fauna mentioned on page 573, has been found in any of them.

MISSOURI BUREAU OF GEOLOGY AND MINES, COLLECTION NO. 5

Fenestella serratula Ulrich

Fenestella serratula var.

Fenestella serratula Ulrich?

Fenestella exigua Ulrich

Fenestella cf. *exigua* Ulrich

Fenestella exigua Ulrich?

Fenestella sp. (3)

Polypora varsoviensis Prout

Polypora striata Cumings

Polypora spininodata Ulrich

Cystodictya lineata Ulrich

Hemitrypa sp.

Schizophoria sp.

Cypricardinia sp.

This is apparently the youngest fauna which has been found thus far. It is characterized by *Polypora varsoviensis*, the large forms of which are found in great abundance in almost every fragment. This species is common in the Warsaw and younger beds. The specimens referred to *Cypricardinia* sp. do not appear to belong to the same species as the ones found in boulder No. 102,

but are closely related. This fauna is probably Warsaw, but, in the absence of detailed faunal studies of the Warsaw, a more exact correlation cannot be made.

Briefly summarized, the results of this study show that the faunas obtained from these residual boulders are much more diverse than has previously been supposed. They indicate a partial submergence, in early Mississippian time, of a considerable portion of the northern end of the Ozark uplift. From the study of so small an area, not much is to be inferred as to the movements and distribution of the Mississippian seas during the time when the formations represented in these boulders were deposited.

Typical Chouteau faunas and pre-Chouteau faunas are conspicuously absent, though farther north the Chouteau formation is represented by small outliers and scattered patches of boulders. From this it would seem as if the sea did not cover this part of the uplift during Kinderhook time, but that a gradual submergence during the late Kinderhook allowed the Burlington seas to invade this area. This supposition is further strengthened by the sandy character of many of the boulders, which suggests that the ancient shore line was not far distant. An alternative view is that the Kinderhook formations, or part of them, were present, and, not being as resistant as the younger formations, have entirely disappeared. However, if this is the case, why should the Chouteau formations occur as boulder deposits in the counties between this area and the Missouri River? On the whole, the evidence seems to favor the first hypothesis.

Not much evidence of the Upper Burlington with its typical crinoid fauna has yet been found, but some specimens in the original School of Mines collection suggest that it was represented. In most places where it is exposed at present it contains much less chert than does the Lower Burlington, and this fact may account for its failure to be more commonly preserved. The Keokuk and the Lower Warsaw are probably both represented, but so great is the similarity between their faunas that the few collections which have been obtained do not suffice to make the distinctions clear. Up to the present time, no evidence has been obtained of any faunas younger than the Lower Warsaw.